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ABSTRACT

During the 1981-82 school year, the American Association of University Women (AAUW), collected mathematics data from school districts throughout the state of Michigan. AAUW is involved in a study of high technology and wanted to find out how education is preparing young people for the world of robotics, biotechnology, telecommunications, and the semiconductor-based technology slated for Michigan's future. Michigan Project of Equal Education Rights (PEER) assisted in the data collection and analysis. Data were obtained from 113 school districts (a number submitting information voluntarily), with 80 districts providing both enrollment data by grade level and sex as well as course enrollment data. Mathematics areas examined included: general mathematics (including business/consumer mathematics), algebra 1, geometry, algebra 2, trigonometry (analytical geometry, precalculus, and other advanced mathematics), calculus, and computer science. Among the findings reported are those indicating: that Michigan has no overall state mathematics program (with over 85 different titles for the 7 mathematics categories studied); a precipitous drop in enrollment of over 50 percent after students complete algebra 1; by grade 12 only 45 percent of boys and 36 percent of girls taking mathematics; and a drop in female enrollment in advanced mathematics regardless of school district size. (JN)

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PEER Math Study Report

Elizabeth Giese

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Introduction

During the 1981-82 school year the American Association of University Women with some help from Church Women United collected math data from school districts throughout the state of Michigan. AAUW is involved in a study of high technology and wanted to find out how education is preparing young people for the world of robotics, biotechnology, telecommunications and the semi-conductor based technology slated for Michigan's future.

Michigan PEER assisted in collecting and analyzing the data. The form used was developed by the National Council of Teachers of Mathematics (NCTM) and was printed in Michigan PEER Perspective with a request to readers for help in collecting the data.

AAUW and Michigan PEER expected to collect data from about 35 to 50 districts. However, many districts sent in the data voluntarily, bringing the number of districts participating in the study to 113. Of these districts, 80 were able to provide both enrollment data by grade level and sex as well as course enrollment data.

The student enrollment patterns of our study reflected the student enrollment patterns of the state as a whole and the State Department of Education has confirmed that the study's 80 districts constitutes a valid sample. The study does not take course content into consideration.

"Why limit your choices? Math opens doors to jobs."

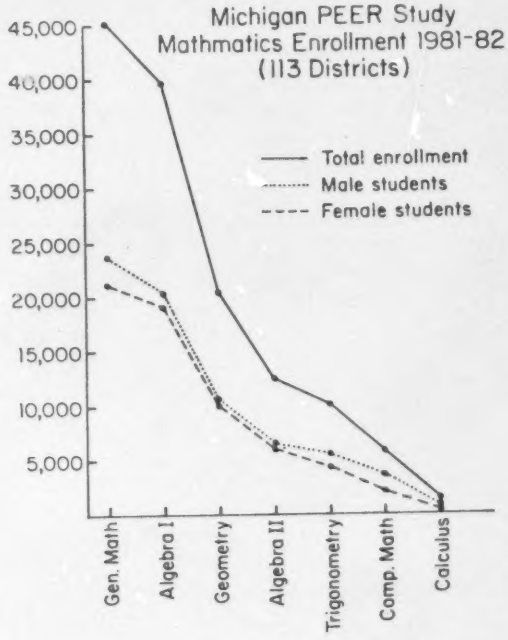
● High school algebra and geometry are needed for many technical jobs not requiring a college degree. ● Four full years of high school math are needed to survive in first year calculus. ● "Hard" calculus college sequences are needed for careers in the sciences and engineering. ● "Soft" calculus college sequences are needed for careers in business, management and economics.

Major Findings

It appears that the majority of students in Michigan schools are not receiving the math education they need to prepare for the high technology society of the future. Without the math they need, the options and opportunities of thousands of school children are automatically limited and the impact is particularly hard on girls.

- The most disturbing finding in the study is the precipitous drop in math enrollment of over 50% after students have completed Algebra I, usually in the ninth grade.

- By the twelfth grade only 45% of the boys and 36% of the girls are taking math, and not all of these students are in courses considered advanced math.



These two patterns of decreased math participation seemed to be fairly consistent regardless of the size of the school districts. Smaller school districts offer fewer advanced math opportunities, districts with over 10,000 students had a greater percentage of girls and boys taking math, but the patterns remained the same.

Recommendations

We hope this citizen-initiated effort will raise the awareness of educators of the need for better math preparation in our elementary and secondary schools and will demonstrate our concern and our support for the following actions:

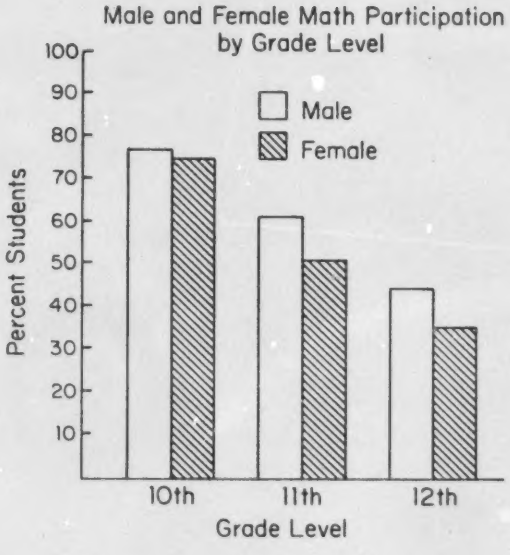
1. Math requirements for high school graduation must be upgraded.

2. Students should be actively recruited into advanced math courses with care given to ensuring the participation of female students.

3. The Michigan Department of Education and local school districts should monitor math education in our state by collecting, analyzing and reporting math participation by course, grade level, sex and race annually.

Math Participation of Girls and Boys by Grade Level

The data which most dramatically showed the difference in math education of girls and boys was the mathematics enrollment data given by grade level. This data does not indicate the level of math course the students are taking, rather it compares the percent of female students taking math at a particular grade level to the number of girls enrolled at that grade level. The data is also presented for boys.



At the twelfth grade level Mt. Pleasant (35%), Fenton (38%), Albion (64%), New Lothrup (17%) and Whitmore Lake (28%) were the only districts in the study to have equal math participation of boys and girls when participation was compared to their grade enrollment.

None of the larger districts showed a greater proportion of girls to boys but among the districts under 3000 students there were eight districts with a greater proportion of senior girls in math than senior boys. However, these small districts are also less likely to offer advanced courses, the courses most likely to show a decrease in female participation. In all other districts the senior male math enrollment was greater than was the female math enrollment.

DATA FOR 80 DISTRICTS — SUMMARY MATHEMATICS ENROLLMENT

	10TH GRADE		11TH GRADE		12TH GRADE	
DIST. SIZE	%MALE	%FEMALE	%MALE	%FEMALE	%MALE	%FEMALE
10000+	90	87	72	62	61	49
5000+	79	76	66	51	56	36
4000+	78	74	54	40	33	26
3000+	82	81	67	60	43	37
2000+	76	76	60	51	41	29
1000+	72	75	46	46	34	26
0-999	61	59	64	49	47	52
SUBTOTALS	77	75	61	51	45	36

Math Participation by Course

General Math and Algebra I

In 8th and 9th grades most districts require math. Nearly all girls and boys take General Math (basic skills, consumer math, business math) and most take a math course comparable to Algebra I. Fewer girls than boys take General Math and an even greater gap shows up in advanced math courses.

Programs vary a great deal. Some districts, for example, appeared to offer consumer math as the basic math requirement for all students. Some districts offer little General Math and begin the math sequence with Algebra I.

DISTRICT	GENERAL MATH				ALGEBRA I			
	TOTAL	# MALE	# FEMALE	% FEMALE	TOTAL	# MALE	# FEMALE	% FEMALE
10000+	17867	9468	8399	47	18148	9500	8648	48
5000+	7985	4175	3810	48	6644	3376	3268	49
4000+	3070	1632	1438	47	4083	2101	1982	49
3000+	3039	1600	1439	47	2207	1106	1101	50
2000+	2869	1503	1366	48	2582	1397	1185	46
1000+	4152	2197	1955	47	2575	1310	1265	49
0-999	1222	634	588	48	710	346	364	51
ISD MONR	4982	2718	2264	45	2846	1329	1517	53
SUBTOTAL	45186	23927	21259	47	39795	20465	19330	49

We looked at business and consumer math to see if it were possible that girls were enrolling in these courses and thus eliminating the possibility of completing the advanced math sequence in their junior and senior years. Relatively few students take business or consumer math; about one in 12 of the 45,186 students in this study were in General Math. Girls make up 47% of the General Math classes and showed about the same tendancy as boys to be enrolled in business and consumer math, rather than basic skills courses. This data seemingly refutes the notion that girls are not in college prep math courses because they are in other math sequences.

DISTRICT	BUSINESS MATH				CONSUMER MATH			
	TOTAL	# MALE	# FEMALE	% FEMALE	TOTAL	# MALE	# FEMALE	% FEMALE
10000+	465	256	209	45	1492	747	745	50
5000+	285	137	148	52	529	314	215	41
4000+	193	80	113	59	262	153	109	42
3000+	129	67	62	48	196	80	116	59
2000+	122	68	54	44	478	249	229	48
1000+	115	67	48	42	353	179	174	49
0-999	95	43	52	55	264	149	115	44
ISD MONR	197	116	81	41	325	181	144	44
SUBTOTAL	1601	834	767	48	3899	2052	1847	47

Geometry and Algebra II

There is a major drop in the number of students enrolled in Geometry, generally a 10th grade class, as compared to students in General Math and Algebra I. Geometry enrollments were 65 percent of the enrollments of Algebra I. This decrease may be in large part due to the one year high school math requirement in most districts.

In 46 of the 113 districts there was a more than 49% female enrollment in Geometry, indicating that in some districts girls are in Geometry in the same or slightly greater proportion to their enrollment in high school (and boys are underrepresented). However, in 61 districts girls are underrepresented in math relative to their overall school enrollment. Still, the overall differences in enrollment between girls and boys are not so great in these early years. At the 10th grade level 77% of the boys were participating in math and 75% of the girls.

Enrollments in Algebra II were only one third the number of students enrolled in Algebra I. This held true for both girls and boys. Overall proportional enrollments of girls in Geometry were 49% and 48% in Algebra II.

The most accurate way for a district to check representation of girls and boys in a math program is to determine the grade level for the course, and then compare the number of girls (or boys) in the class to the number of girls (or boys) at that grade level. However, this was not possible when dealing with this data as a whole since grade levels targeted for classes varied greatly by district.

DISTRICT	G E O M E T R Y				A L G E B R A II			
	TOTAL	# MALE	# FEMALE	% FEMALE	TOTAL	# MALE	# FEMALE	% FEMALE
10000+	8605	4492	4113	48	4871	2534	2337	48
5000+	5002	2507	2495	50	3588	1827	1761	49
4000+	1920	1093	827	43	1151	634	517	45
3000+	1034	508	526	51	865	445	420	49
2000+	1577	787	790	50	907	464	443	49
1000+	1215	608	607	50	903	463	440	49
0-999	323	150	173	54	294	161	133	45
ISD MONR	980	479	501	51	182	88	94	52
SUBTOTAL	20656	10624	10032	49	12761	6616	6145	48

Trigonometry, Calculus and Computer Science

The data does substantiate the supposition that girls are not completing math sequences at the same level as are boys in Michigan schools. The early male/female proportional gap is in General Math. This difference at the earlier level may offer a partial explanation for the decline in math enrollments for girls at the senior grade level.

Trigonometry and Calculus are advanced math courses usually offered in the senior year. Students taking Calculus need to start their math sequence earlier, perhaps in 8th grade, in order to complete the advanced math courses needed for Calculus.

Only a little over one third of the districts in this study offer Calculus. Most districts with enrollments under 2000 students do not offer Calculus. Trigonometry is offered by all but a handful of the smaller districts. Analytical Geometry, Precalculus and other advanced math courses have been included in the Trigonometry category.

For the 80 districts supplying grade level enrollment data we found only 51% of the eleventh grade girls and 36% of the twelfth grade girls taking math, as compared to 61% of the eleventh grade boys and 45% of the twelfth grade boys. These figures do not take into account the level of difficulty of the math class taken.

Overall statistics for Trigonometry courses in the same 80 districts showed a 44/56 proportion of females and males in these classes. For Calculus the proportion was 37/63 for female/male classroom participation. (Girls and boys make up about a 49/51 proportion of the high school enrollment.)

DISTRICT..	T R I G - P R E C A L C..				..C A L C U L U S..			
	TOTAL	# MALE	# FEMALE	% FEMALE	TOTAL	# MALE	# FEMALE	% FEMALE
10000+	4198	2321	1877	45	418	246	172	41
5000+	2733	1593	1140	42	558	329	229	41
4000+	1050	619	431	41	258	174	84	33
3000+	547	284	263	48	82	51	31	38
2000+	830	480	350	42	73	47	26	36
1000+	423	264	159	38	52	25	27	52
0-999	134	67	67	50	0	0	0	0
ISD MONR	281	140	141	50	38	22	16	42
SUBTOTAL	10196	5768	4428	43	1479	894	585	40

Underrepresentation of girls in Computer Science seemed to be present in districts regardless of the size of the districts, as this chart for the 54 districts illustrates. About half the districts in the study (54) offered Computer Science and two districts offered Independent Study to a small number of students. Almost all districts (89%) with over 4000 students offered Computer classes. Only 32% of the districts under 4000 students offered Computer Science. Computer Science (also called Computer Math) is generally a class for 11th or 12th graders.

DISTRICT..	C O M P U T E R	M A T H..		
	TOTAL	# MALE	# FEMALE	% FEMALE
10000+	2143	1319	824	38
5000+	2286	1512	774	34
4000+	739	522	217	29
3000+	249	141	108	43
2000+	345	208	137	40
1000+	113	68	45	40
0-999	27	17	10	37
ISD MONR				
SUBTOTAL	5902	3787	2115	36

Advanced Enrollment

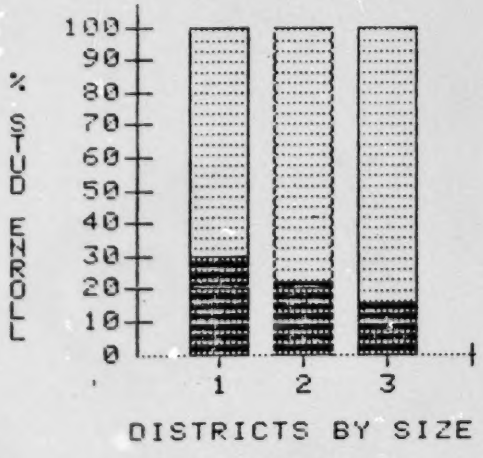
Lack of participation of 11th and 12th grade girls in math seems particularly difficult to explain in view of the findings of the Michigan Educational Assessment Program over the past five years. Results have shown girls to be consistently higher than boys in both math and reading at all three testing levels (4th, 7th and 10th grades).

In districts with student enrollments under 2000 we compared the number of students enrolled in Algebra II, Trigonometry, Computer Science and Calculus to the number of students in eleventh and twelfth grade. The advanced math enrollment represented 16% of the student enrollment for these grades. For school districts between 2000 and 4000 the percentage of 11th and 12th grade students in advanced courses was 23%. In districts over 4000 students the figure was about 30%.

ADVANCED MATH

11-12th Grade Enrollment

1. 23 districts with over 4000 students (30%)
2. 21 districts with 2000 to 4000 students (23%)
3. 36 districts with under 2000 students (16%)



The table below is organized by district size. It illustrates both the pervasive drop in math enrollment at the advanced math sequence level and the corresponding loss of female enrollment. The eleventh and twelfth grade enrollment statistics are provided to give a sense of the student pool available at the advanced math sequence level.

Enrollment 10,000+ (7 districts)

	Grade	Total	% female	Course	Total	% female
Advanced Math	Eleventh	9743	49	Algebra II	3571	49
80 Districts	Twelfth	9654	49	Trigonometry	3165	46
				Comp. Science	1496	37
				Calculus	320	40

Enrollment 5,000+ (8 districts)

Grade	Total	% female	Course	Total	% female
Eleventh	4096	50	Algebra II	1523	47
Twelfth	4049	50	Trigonometry	1043	41
			Comp. Science	1025	33
			Calculus	147	35

Enrollment 4,000+ (8 districts)

Grade	Total	% female	Course	Total	% female
Eleventh	2835	47	Algebra II	915	47
Twelfth	2711	49	Trigonometry	894	42
			Comp. Science	454	37
			Calculus	210	33

Enrollment 3,000+ (7 districts)

Grade	Total	% female	Course	Total	% female
Eleventh	1990	49	Algebra II	717	49
Twelfth	1951	51	Trigonometry	463	49
			Comp. Science	167	42
			Calculus	82	38

Enrollment 2,000+ (14 districts)

Grade	Total	% female	Course	Total	% female
Eleventh	2775	49	Algebra II	742	50
Twelfth	2832	47	Trigonometry	808	42
			Comp. Science	328	41
			Calculus	73	36

Enrollment 1,000+ (22 districts)

Grade	Total	% female	Course	Total	% female
Eleventh	2651	48	Algebra II	821	49
Twelfth	2727	48	Trigonometry	385	38
			Comp. Science	101	36
			Calculus	13	46

Enrollment 0 - 999 (14 districts)

Grade	Total	% female	Course	Total	% female
Eleventh	714	47	Algebra II	218	49
Twelfth	717	46	Trigonometry	117	49
			Comp. Science	27	37
			Calculus	-	-

Curriculum Course Titles

One additional finding emerged: the study revealed no overall state mathematics program. The 113 local districts offered over 85 different titles for the seven math categories studied. This may possibly be a problem which may have to be addressed on the way to upgrading our math programs.

Math
Practical Math
Math in Life
FSL Math
Math Concepts
Math Skills
Math III
Technical Math
Career Math
Industrial Math
Math Lab - Remedial
Competency Math
8th Grade Math I, II, III
Applied Math
Basic Math
Math Lab
Senior Math
Cultural Math
Business Math II
Math 12
College Math
Vocational Math
Advanced Math
Remedial Math
Shop Math
Modern Math
Low Math
I.U. Math
Special Education Math
Introduction to High School Mathematics
Prescription Math
General Math II

Refresher Math
Consumer Math
Algebra
Elementary Algebra
Intermediate Algebra
Algebra Related Topics
Basic Algebra
Foundations of Algebra
Beginning Advanced Algebra
Algebra II Honors
Algebra III Honors
Algebra I, II, III
College Algebra
Pre Algebra
Introductory Algebra
Practical Algebra
Career Algebra
Advanced Algebra
Geometry
Elementary Geometry
Applied Geometry
Advanced Geometry
Fundamental Geometry
Beginning Advanced Geometry
Continuing Advanced Geometry
Accelerated Geometry P1. & S.
Analytic Geometry Functions
Freshman Geometry
Modern Geometry
Trigonometry
Trigonometry/Functions
Applied Trigonometry
Honors Trigonometry
Trigonometry/Analytic Geometry

Calculus
Analysis Calculus
AP Calculus
Honors Precalculus
Calculus Analytic Geometry
Computer
Data Processing
Advanced Computer
Fortran
Computer Studies
Computer Programming
Computer Science
Computer Math
Computer Concepts
Cobol
Advanced Data Processing
Advanced Computer Programming
Survival and Computational
Elementary Functions
Trade and Industry
Independent Study
Accelerated (8th Grade)
Alternative Education
Accounting
Honors
Bookkeeping
General Arithmetic
Analysis
Advanced Arithmetic
Probability and Statistics
Senior High Refresher
Advanced Placement
Introduction to Analysis
Metrics

Summary

Four main points must be made as a result of this study:

- too few students are getting the advanced math preparation they need to meet the challenges facing them in the decades ahead,
- too few students are being prepared to meet the needs of the skilled trades and technological professions on which Michigan's economic future may depend,
- the drop in female participation in all advanced math courses exists regardless of the size of the school district, and
- fewer students have the opportunity to take advanced courses in math in the smaller districts than in the larger districts.

Data Collection and Compilation

The data collected came from 113 school districts. About half of the data was collected by the American Association of University Women with some additional help from Church Women United and local PEER sites. The remainder was contributed voluntarily by local school districts responding to a PEER newsletter request. The data is for the 1981-82 school year.

District student enrollment	Study total	Incomplete forms	
10,000+	12	5	
5,000+	13	5	
4,000+	11	3	
3,000+	10	3	
2,000+	16	2	
1,000+	25	3	
0-999	17	3	
Monroe ISD	9	9	
	113	33	= 80 complete forms

The form used was developed by the National Council of Teachers of Mathematics (NCTM). It requested math course data for each grade level by sex and also the total enrollment of male and female students at each grade level. School districts were then requested to calculate the male and female proportional enrollment at each grade level and compare it to the proportional enrollment of male and female students at that grade level. Fourteen course descriptions were given.

One hundred nineteen districts contributed data on this form, however, six forms had to be discarded because there was data for only a few courses or one or two grade levels. Of the 113 districts with useful data only 80 had data available for grade enrollment as well as course enrollment.

The Monroe Intermediate School District data represents nine school districts and was not broken out by district. Most of the Monroe ISD districts are small, with one (Monroe Public Schools) in the 5000+ category.

While the NCTM form was very useful in analyzing math opportunities for individual school districts it proved difficult to use when comparing districts. To simplify the job the course data was reorganized using a form developed by EQUALS (Math/Science Network, U. of Calif., Berkeley). The EQUALS form did not require grade level breakdowns of course enrollments or total grade level enrollment data. Because school districts have such widely varying course titles it was easier to lump them into these broader course areas than to compare them course to course. In addition to this data we also pulled out the business and consumer math courses and looked at them independently of the General Math category as well as including them in the General Math category. The EQUALS categories are:

General Math (basic skills, consumer, business)
Algebra I (first-year algebra even if given in more than 2 semesters)
Geometry
Algebra II (second-year algebra with or without trigonometry)
Trigonometry (analytical geometry, precalculus and other advance math)
Calculus
Computer Science

The districts were then separated by student enrollment for the district (K-12). About 86% of the districts in Michigan have under 5,000 students. About 10% are in the 5000 to 10,000 students category, 3% in the 10,000 to 20,000 size category and 1% have over 20,000 students (according to the 1981 Michigan Education Directory listing of 540 districts). Our study followed the student enrollment demographics of the state as a whole, but we were a little short of districts under 2000 students in particular.

Student Enrollment District Size

Students	State	PEER study*
0-4,999	86%	76%
5,000-9,999	10%	12%
10,000-19,999	3%	10%
20,000+	1%	2%

* 113 districts

The data was then recorded with Visicalc on an Apple II computer. Districts were listed by size. Those districts that were not included in the analysis of the 80 school districts because of incomplete data are noted with an asterisk. All 113 districts had data necessary for the computerized presentation of data using the EQUALS form and analysis.

A summary of this data is provided for each size district and for each course category. "Enrollment all Classes" refers to all math classes listed (not school enrollments). NOTE: Business Math and Consumer Math are counted as part of the General Math category.

(The additional data mentioned above is available from PEER on floppy disk 3.3 DOS, or photocopy at cost. Please contact Michigan PEER if you are interested in obtaining this data: 211 E. Commerce, Milford, MI 48042, 313-685-0917.)

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